EMC Test Adapter for MTCA.4 Modules

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b1 Engineering Solutions: Markets and Solutions

Automotive

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M2M/Internet-of-Things & High-Speed-Connectivity

Functional Safety

Concepts & Innovations → **Design, Development, Test & Documentation** → **Lifecycle Services**

The MTCA.4 EMC Challenge

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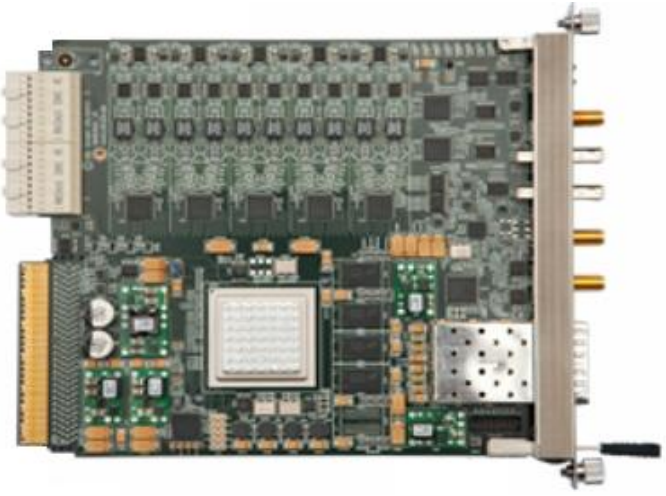
All boards within a crate influence each other:

- *All boards are coupled via GND*



- *Near field/far field interference between neighbouring boards*
- *Boards from different manufacturers*
- *Noise from neighboring boards may limit performance*

Pictures by courtesy of DESY

Modelling and Classification of MTCA.4 Boards

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- *Modelling of the GND system by means of equivalent circuits.*
  See: GND Modelling of MTCA.4 Crates (3rd MTCA Workshop)
- *Definition of sensitivity classes giving limits on emission and immunity for all coupling paths.*
  - *Evaluate the model parameters, e.g. the impedances of the equivalent circuits*
  - *Quantify the susceptibility of components (signals, power supply, ..)*
  - *Calculate the effectiveness of shielding/filtering/distance on noise attenuation*
  - *Define the allowed noise levels*
- *In-System Classification of AMC-Modules*
  - *system dependent*
  - *portability to other systems?*

Stand Alone Classification of AMC-Modules

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Conductive Coupling

- *Emission*
  - *Measurement Setup:*
    stand alone characterization of active components: AMC
    frequency domain: spectral density (e.g. 10Hz – 100MHz)
    time domain: voltage / current
  - *Measurement Parameter:*
    noise voltage/current payload voltage and on GND
    (each referenced to measurement GND)
  - *Limits: integral, set of curves - values: t.b.d.*

- *Susceptibility*
  - *Measurement Setup:*
    well defined interfering signal applied to AMC
    continuous signal, transient signal
  - *Measurement Parameter:*
    full functionality of AMC (to be defined in specification of module under test)
  - *Limits*
    amplitude of continuous wave signal at certain frequencies
    amplitude and duration of transient signal

Radiation

- *still open*

EMC Adapter Board Concept

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Provide the possibility to evaluate the EMI behavior of AMC modules by spectral or time domain measurements of ground noise currents and voltages

- *Standardized AMC connector for AMC card plug-in*
- *Management and payload power supply*
- *Power management*
- *Clock generation*
- *Selected fat pipe connections*
- *Basic IPMI functionality (hot-swap, temperature surveillance, …)*
- *stand-alone operation*
  or
  within a MTCA crate replacing the backplane, power module and MCH
  → *form factor of MTCA backplane*

EMC Adapter Board Measurement Principle

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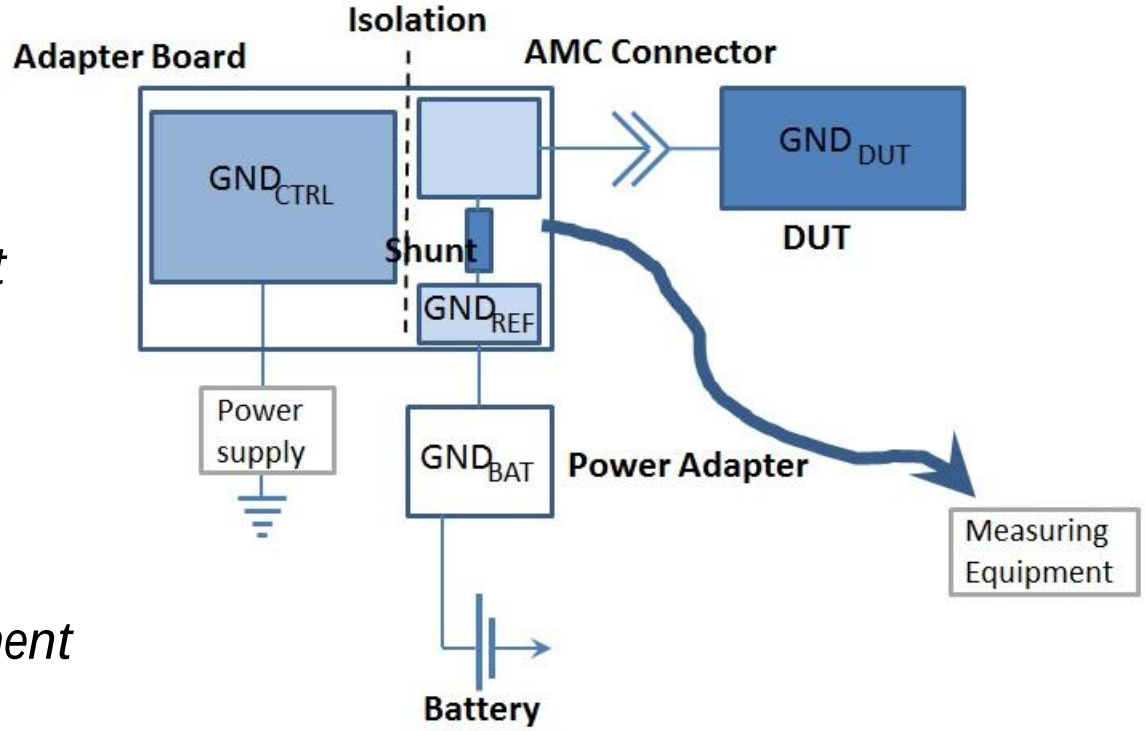
- *Measurement of GND current via a shunt resistor*
- *Grounding concept*
  - *Battery supply*
    avoid earth loops
    & noise from external equipment
  - *Galvanic isolation of*
    control & measurement
  - *measurements may use the*
    ground of the measuring equipment



Controller Block Diagram

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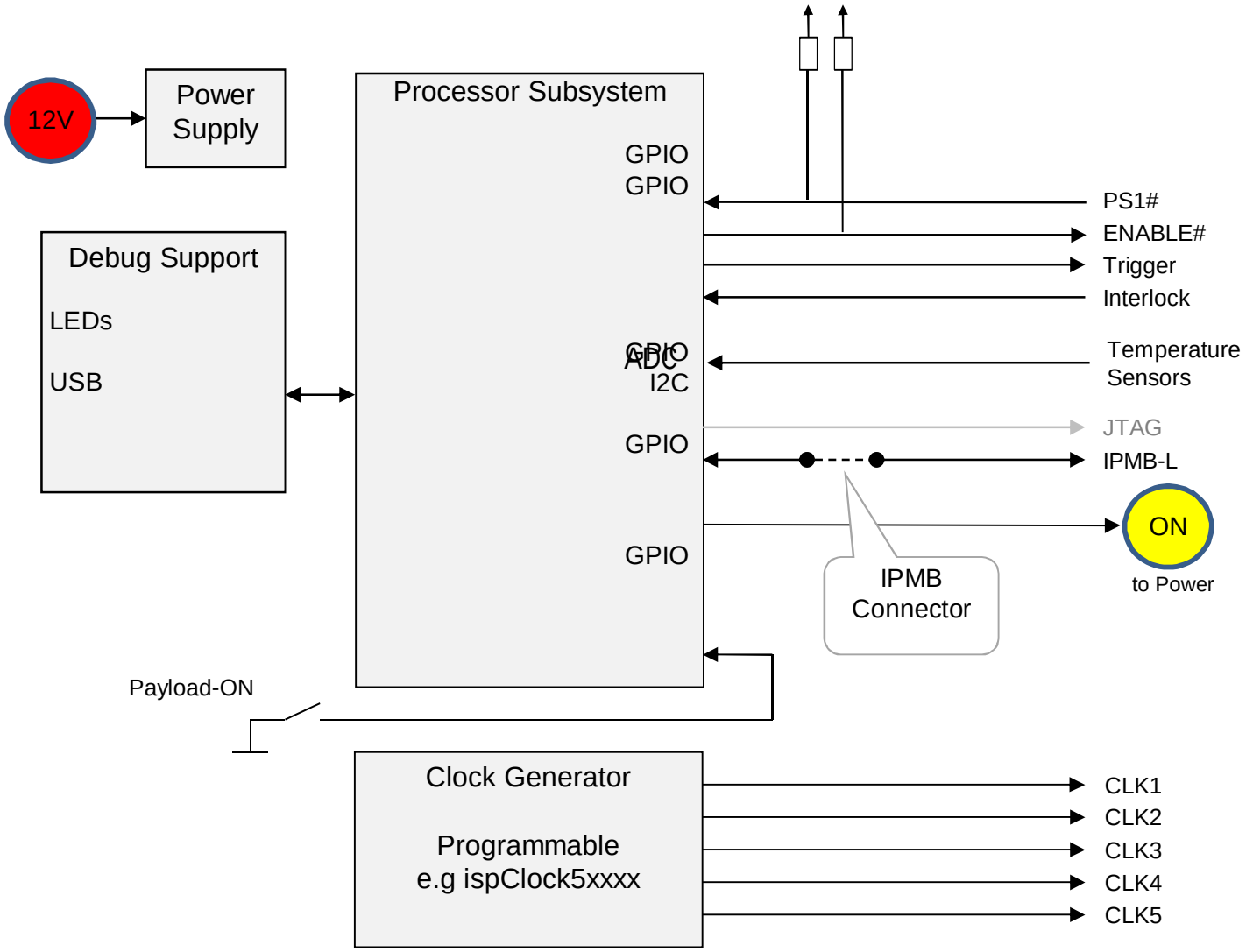

Controller
HW Functions

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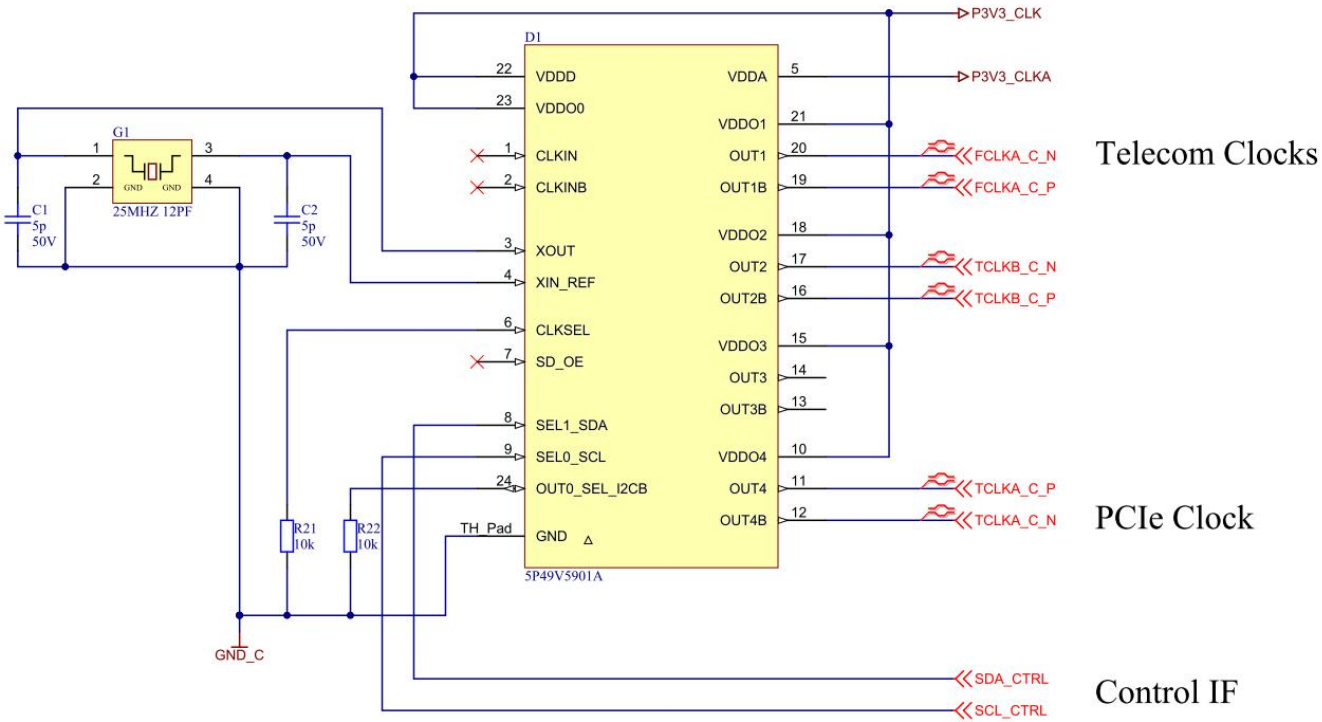
- *Processor ATXMEGA128A1-A*
- *Provide I^2C interface for IPMB-L (communication with AMC board) selectable via processor subsystem and connector via jumper.*
- *Detect present signal PS1#*
- *Generate ON signal to Power Adapter*
- *Generate ENABLE# signal to AMC*
- *Temperature surveillance of the AMC module which indicates critical temperature and shutdown the AMC if the temperature exceeds the tolerable limit.*
- *Provide programmable backplane clocks*
- *Provide Control&Interlock Signals*

Clock Generator

- *Programmable Clock Generator*
- *I²C serial programming interface*
- *Differential Outputs*
- *LVDS*
- *1MHz to 350MHz*



PCIe Connection

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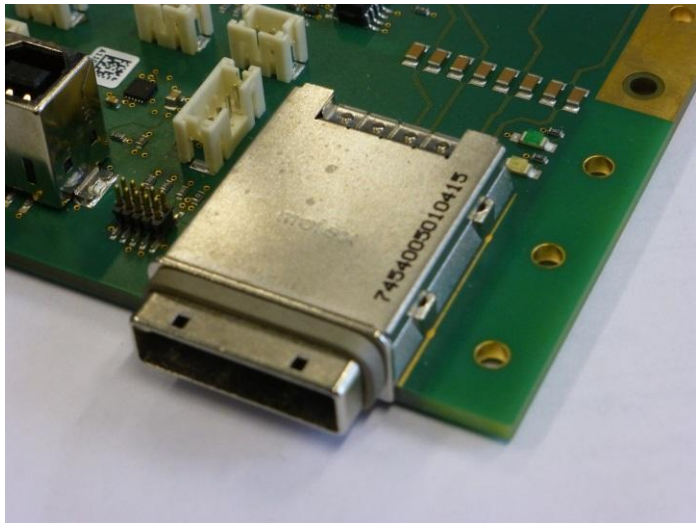
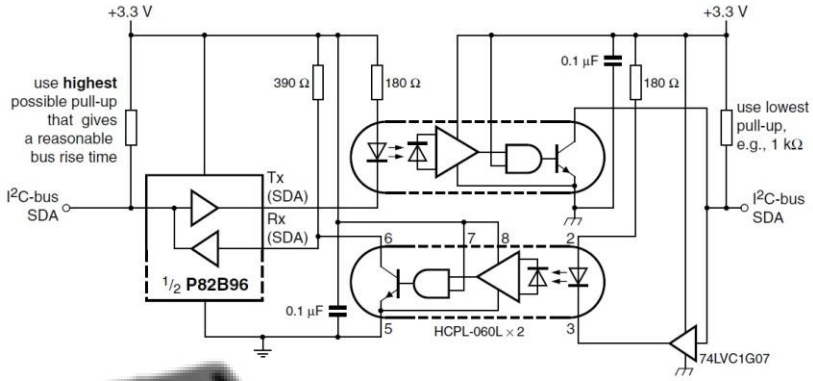
- *external PCIe x4 Interface*
- *AMC Port 4 to7*
- *Standard PCIe connector*
- *Signals have to be provided from PC*
- *Galvanic Isolation possible using optical interface e.g. SAMTEC*

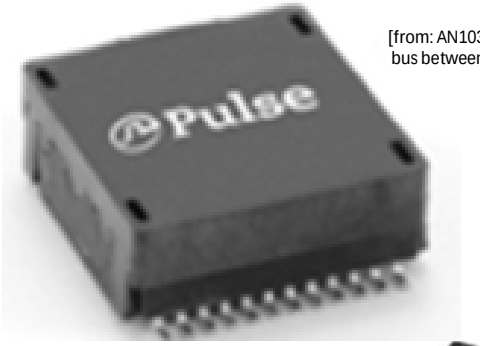


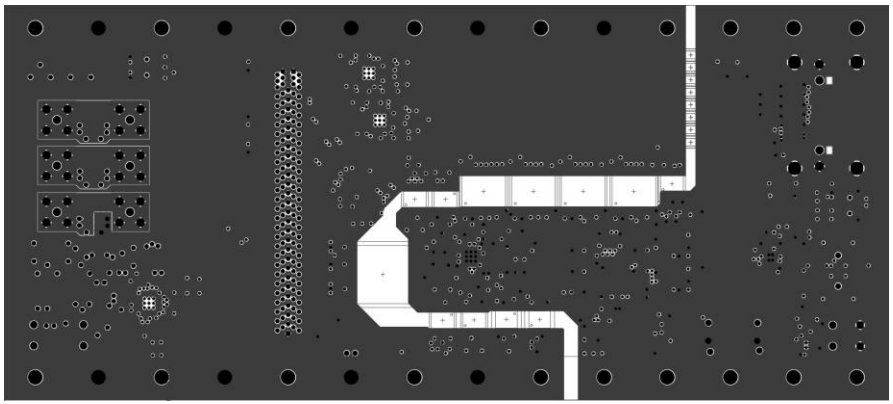
Galvanic Isolation

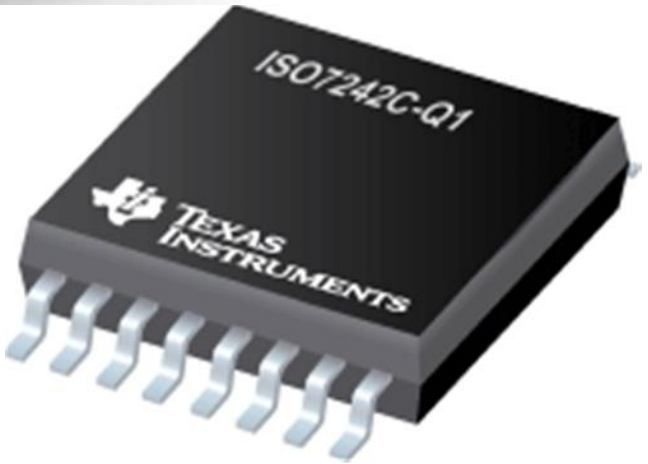
- *Between controller & measurement part of adapter board*
- *Opto coupler for I²C and static signals*
- *Capacitors for PCIe*
- *Transformer for LVDS clocks*
- *Digital isolators for Trigger&Interlock*



[from: AN10364 Opto-electrical isolation of the I2C-bus (operating the bus between points with different local ground potential), NXP, Nov 2010







AMC Power Supply Block Diagram

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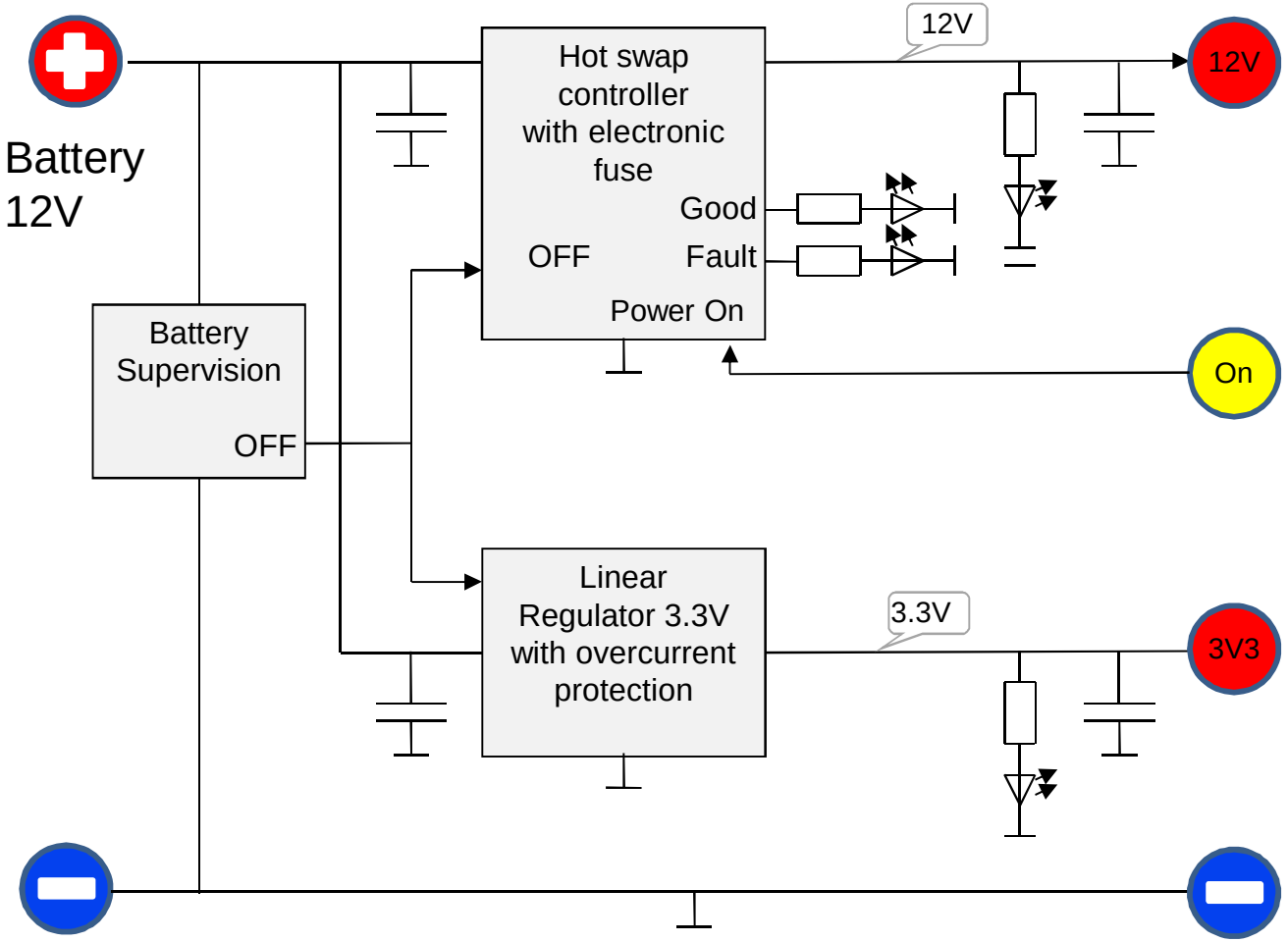
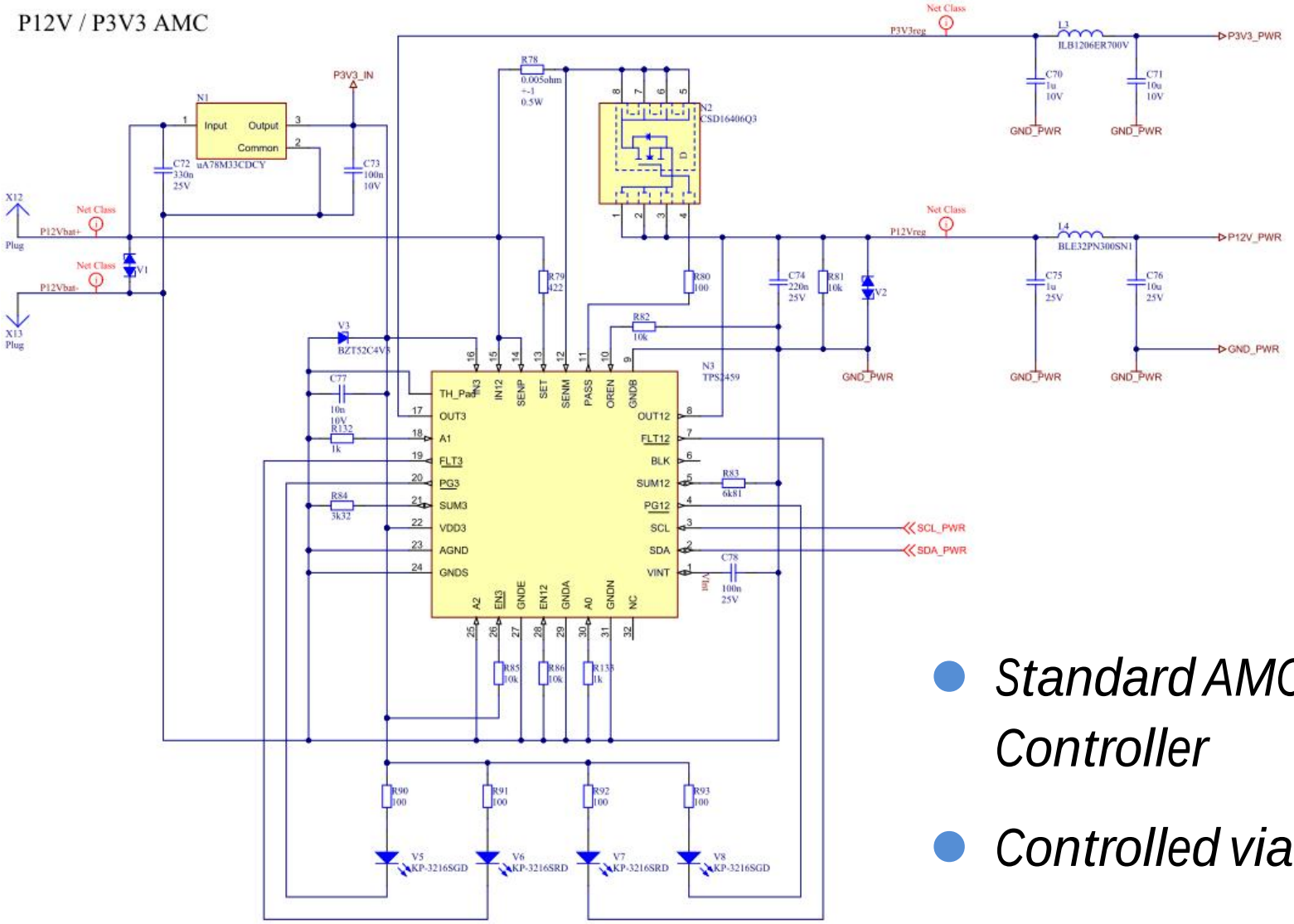


Hot Swap Control



- *Standard AMC Hot Swap Controller*
- *Controlled via I²C*
- *Additional 3.3V for Optocoupler*

Current Measurement

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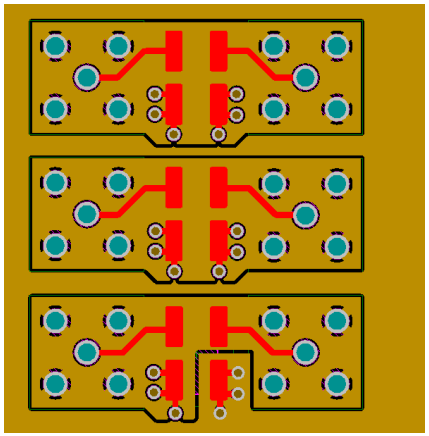
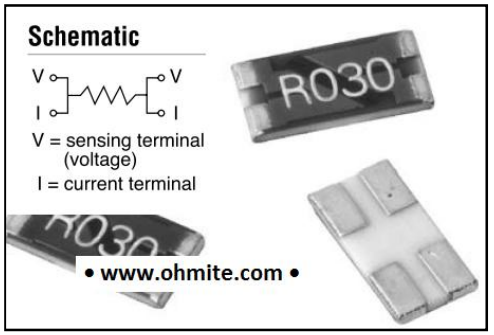
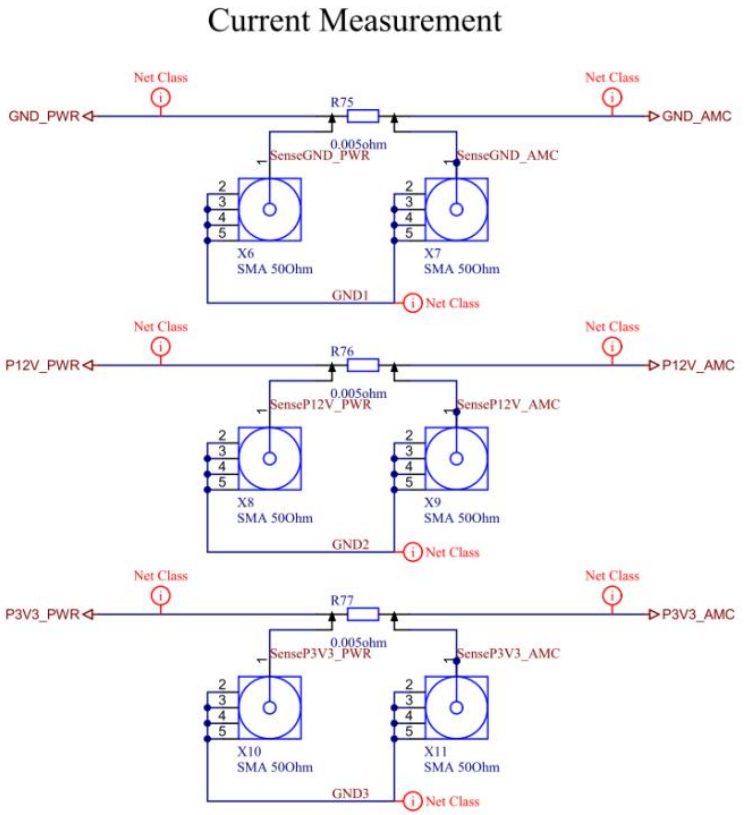
- *Four Terminal High Precision Current Sense*
- *Measurement GND separated*
- *Connection via SMA connectors*







Board – Component Side

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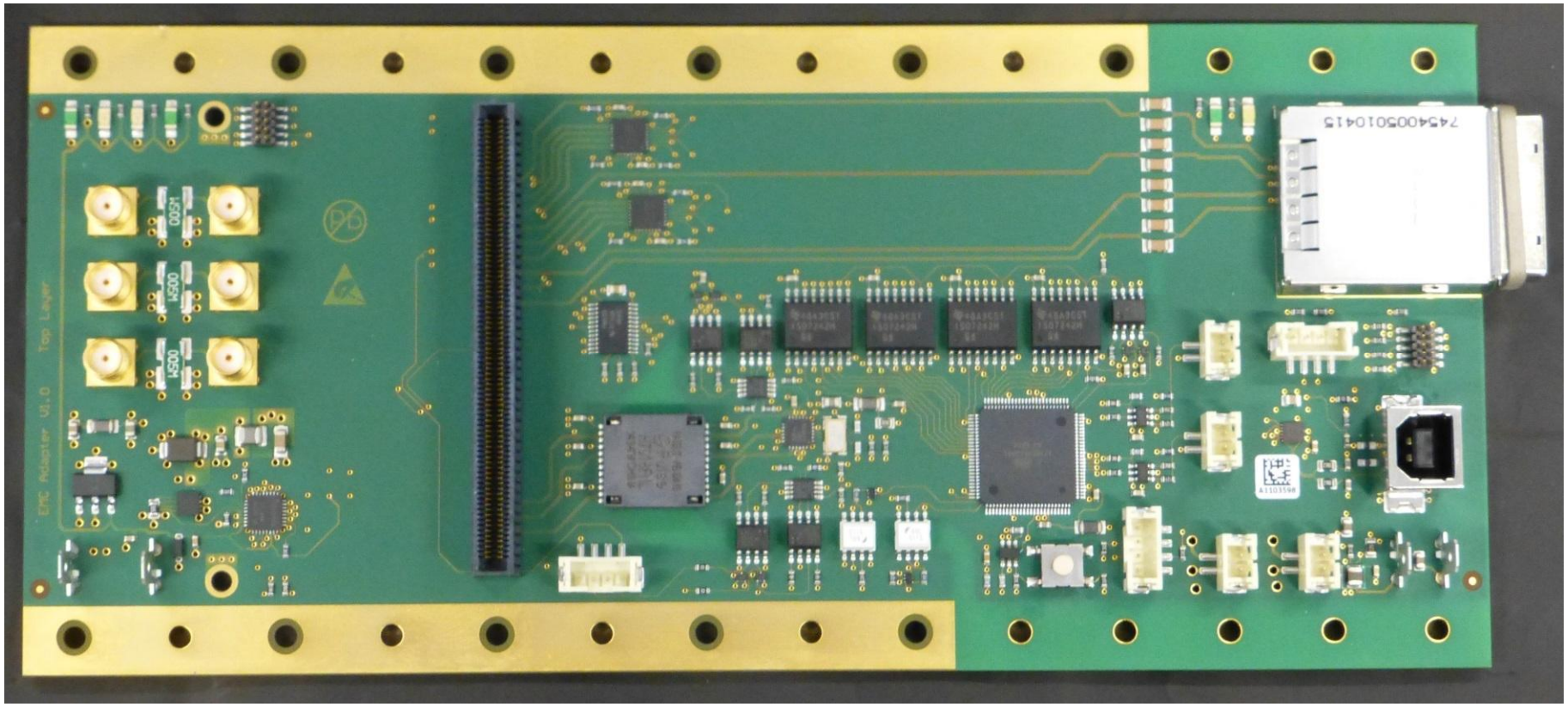

Board – Solder Side

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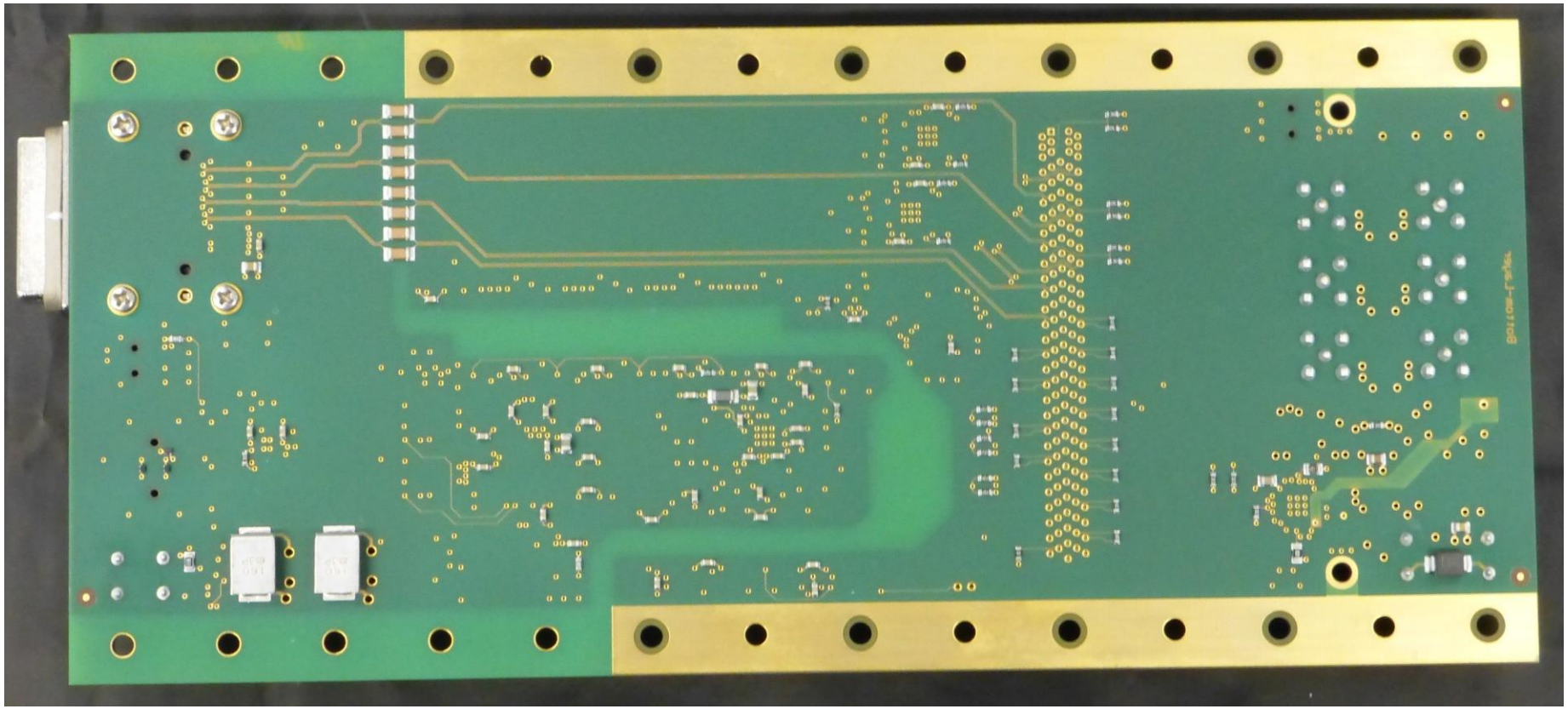

Setup with AMC/RTM Board

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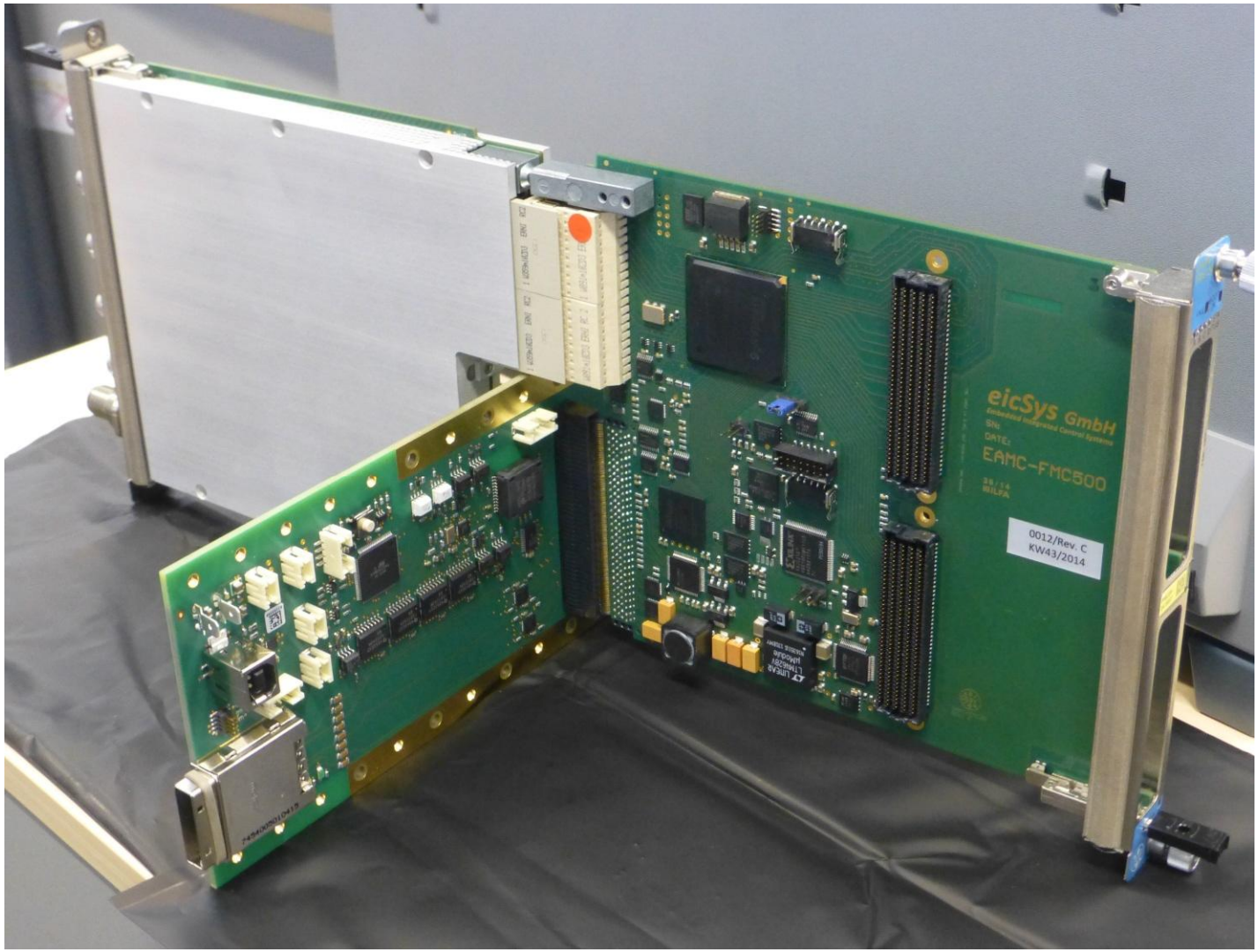

First experiences
Hardware Bring Up

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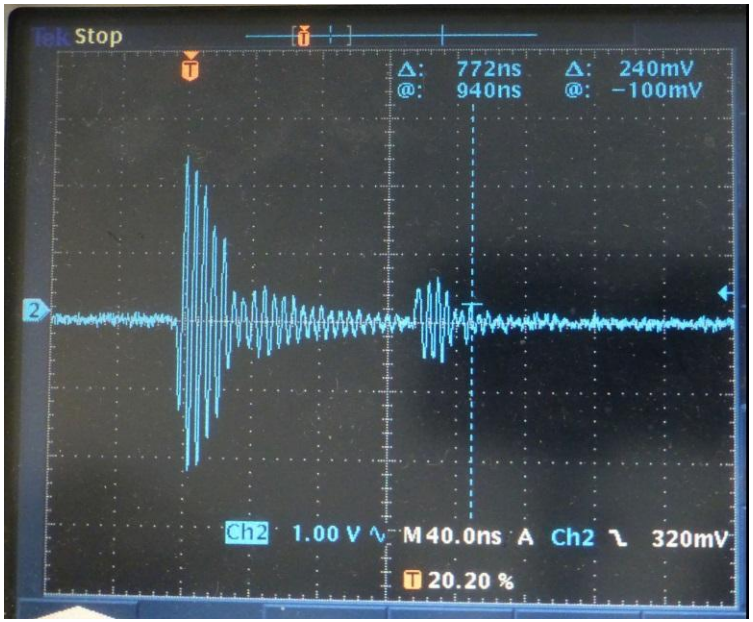
- *Hardware is basically working*
  (after some small modifications)
  PCIe / Trigger&Interlock signals not yet tested

- *Problem:*
  3.3 V Controller Power Supply
  extremely susceptible for over/undervoltages
  generates very high noise levels

- *Workaround: external 3.3 V supply*



First experiences
Firmware Bring Up

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- *only basic features tested up to now*
- *Power on of AMC module ok*
- *Programming of Clock generator is working*
- *IPMI not yet tested*
- *Terminal interface via USB only unidirectional*

Conclusion & Outlook

- *An Adapterboard has been developed to measure noise current that an AMC module introduces to a MTCA.4 system*
- *The measured currents can be used for classifying boards according their contribution to the noise budget of the MTCA.4 system*
- *Using a standalone adapter eliminates system influences*
- *Applying strict galvanic isolation between control electronics and the measurement part reduces noise floor of the measurement setup*
- *Up to now no valid measurements due to low power consumption of tested modules*

Next:

- *Measurement of modules with higher power consumption*
- *Analyzing measured results in order to develop a classification scheme*

Thank you

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